DESIGN CONSIDERATIONS
FOR SPECIAL CARE UNITS IN HOSPITALS

DIAGNOSTIC ULTRASOUND SERVICES IN HOSPITALS

HEALTH FACILITIES DESIGN DIVISION
HEALTH RESOURCES DIRECTORATE
HEALTH SERVICES AND PROMOTION BRANCH

PUBLISHED BY AUTHORITY OF THE MINISTER OF
NATIONAL HEALTH AND WELFARE

INTRODUCTION

BACKGROUND

Concern shown by government and hospital authorities over the emergence of separate units (dedicated to specialized diagnostic and treatment techniques) within institutions was voiced by members of the Health Insurance Federal-Provincial Advisory Committee and its Sub-Committees. As these new techniques came into being, inadequacies in existing guidelines and standards became evident, not only with respect to the planning, organization and operation of "special services units", but also with regard to the physical accommodation and services provided in housing them.

It is within this context that this set of design guidelines for planning the physical accommodation for these services is produced.

OBJECTIVE

The objective of this series of Design Guidelines is to review, in terms of design implications, operational and other related aspects of providing special health care services in hospitals.

These publications are presented for the use of architects, engineers and other professionals involved in health facility planning.

RELATIONSHIP TO OTHER PLANNING GUIDELINES

These Design Guidelines complement the publication entitled "Guidelines for Establishing Standards for Special Services in Hospitals"*, and should be read together.

Direct relationship will also exist between the Health Facilities Design (HFD) Design Guides and HFD "methodologies" dealing with the evaluation and space programming for certain hospital departments. The "Evaluation and Space Programming Methodologies" (presently being developed), together with a carefully written "services program"**, and the other two guidelines mentioned above, will form a complete approach to planning for special services units in hospitals and the basis for establishing a functional program***. (It is important to note that in order to avoid over or under design when planning a unit for one of the special services, a Service Program be established before Design Guidelines are consulted.)

GENERAL

Health Facilities Design intends to refine and update the Design Guidelines periodically and therefore invites the readers to submit comments and suggestions to the Director, Health Facilities Design, Health Resources Directorate, Health Services and Promotion Branch, National Health and Welfare, Ottawa, Ontario, K1A 1B4.

---

* Report of the Working Party on Special Services in Hospital 1978. Published by NH&W, Health Services Directorate, Health Services and Promotion Branch.

** "Services program" is a detailed written statment of the services that will be provided and the means through which they will be provided.

*** "Functional program" is a description of activities, processes, people, and equipment necessary to perform a service at a projected workload level.

ACKNOWLEDGMENTS

The production of this guideline represents the contribution of many individuals, specialists in their respective fields: organizations and professional associations. Of special interest to the physicial planning team was the time and advice given by the personnel of the units being examined. (See at the end of this publication the list of institutions visited by the team).

This guideline and the others of the series were prepared by the Health Facilities Design Division's physicial planning guideline team comprising:

Mr. Roger Diab - Team leader and at various phases

H. Callan	R. Malette
S.T. Morawski	A. Croteau
J.C. Mayes	Lise Careau
B. Laing	Christine Scheel

T.M. Ogrodnik,
Director,
Health Facilities Design,
Health Resources Directorate,
Health Services & Promotion Branch,
Health and Welfare Canada.

LISTS OF UNITS IN THE PROGRAM

Renal Dialysis Services
Cardiac Care Unit
Cardiac Surgery Unit
Burn Unit
Intensive Care Unit
Nuclear Medicine in Hospitals
Diagnostic Ultrasound Services in Hospitals
Computed Tomography
Day Surgery Unit
Diabetic Day Care Unit
Detoxication Units
Narcotic Addiction Treatment Unit in Hospitals
Dental Unit in Hospitals
Geriatric Units in Hospitals and Geriatric Day Hospitals*
Rehabilitation Medicine Unit
Respiratory Technology Unit

**Perinatal Intensive Care Unit
**Total Parenteral Nutrition Service in Hospitals
**Psychiatric Services provided by Hospitals

* This volume consists of two units; they were considered sufficiently related to be joined in one volume.

** The design considerations of these units will be published at a future date.

TABLE OF CONTENTS

1. **ARCHITECTURAL DESIGN CONSIDERATIONS**

- 1.1 Introduction
- 1.2 Description of Major Activities for Scanning a Patient
- 1.3 Major Functions in the Unit
- 1.4 General Planning Considerations
- 1.5 Circulation
- 1.6 Privacy
- 1.7 Other Space Requirements
- 1.8 Equipment
- 1.9 Storage and Retrieval of the Recorded Image
- 1.10 Materials
- 1.11 Audio-visual Teaching Requirements

2. **MECHANICAL DESIGN CONSIDERATIONS**

- 2.1 General
- 2.2 Plumbing
- 2.3 Fire Protection
- 2.4 Medical Gases
- 2.5 Environment Control

3. **ELECTRICAL DESIGN CONSIDERATIONS**

- 3.1 Power Supply Characteristics
- 3.2 Emergency Lighting
- 3.3 Switches and Receptacles
- 3.4 Communication Systems
  - 3.4.1 Voice Paging Systems
  - 3.4.2 Intercommunication System
  - 3.4.3 Telephone System
- 3.5 Lighting
- 3.6 Closed Circuit Television Systems
- 3.7 Fire Alarm System
- 3.8 Grounding
- 3.9 Equipment Maintenance

1. ARCHITECTURAL DESIGN CONSIDERATIONS

1.1 Introduction

Diagnostic ultrasound is an imaging technique which relies on echoes arising from substances within the human body. These echoes are transformed into images by sophisticated electronic machines. The ultrasound devices do not utilize either X-rays or radio-nuclides; rather they rely on non-invasive techniques, i.e., they do not measure the absorption of X-rays or radio-nuclides by the body. In basic terms* "the transmitting unit or transducer produces sound waves which are coupled to the patient's skin with a film of mineral oil. The transducer also acts as a receiver for the echoes returning from within the body, and converts them to electric impulses. After electronic processing the signals are displayed as an image on an oscilloscope or, in more recent devices on a T.V. screen. In the former, each echo is represented as a bright dot whereas in the latter, echoes of varying intensity are portrayed as various shades of gray upon the image screen."

Based on this description the diagnostic ultrasound unit, as its title shows, is not a patients' ward. It functions as a diagnostic unit similar to X-ray and nuclear medicine; usually it serves both in-patient and out-patients.

In future, health care institutions will probably see the grouping of all imaging techniques in one area of the hospital: X-ray, diagnostic ultrasound, computerized tomography, and nuclear medicine. This grouping is important because of the strong inter-relationship among them. However, it is important to realize that none of these techniques can replace the others. They all act as a system, complementing each other to offer an array of imaging capabilities, the main objective of which is the better diagnosis of diseases.

1.2 Description of Major Activities for Scanning a Patient

1) The patient is brought in and either is transferred on the examining table (this applies where the table is an integral part of the fixed equipment), or the patient's stretcher becomes the examining table (this applies when the scanning equipment is separate).

2) The patient's skin in the areas to be examined is anointed with a special oil.

3) The doctor holds a transducer in his hand and moves it back and forth over the patient's skin.

4) The sound waves produced by the transducer penetrate the body and echo back into the transducer. They are converted to electric impulses,

---

* Wayne S. Chiliote, M.D., Factors in Ultrasound Department Design, Planning Guide for Radiologic Installations, Edited by William J. Tuddenham, M.D.

and end up after further electronic processing on a monitor screen, taking the form of either an image or an oscilloscope diagram. Usually the image could appear simultaneously on other T.V. viewers in the room, or outside it for teaching purposes.

5) When the scanning arm and the examining table are not integrated, the electronic section forms a separate entity that could be moved to any radiographic examining table or, as mentioned before, to the patient's stretcher.

6) The sophisticated models of examination tables allow for various patient's positions: they have provision for elevation, rotation, and tipping for head or foot elevation.

7) After the examination:

- the out-patient goes to changing, gets dressed and checks out at the reception desk;
- the in-patient is taken to his bed;
- the doctor washes his hands and leaves the room;
- the nurse changes the linen of the examination table and prepares the room for the next patient; she then calls in the next patient.

8) Viewing and dictating of the report by doctors, as well as discussions of the case with other colleagues, would occur in other locations.

1.3 Major Functions in the Unit

1) Reception
2) Interview
3) Waiting
4) Patients' changing
5) Ultrasound examination
6) Check out
7) Staff changing
8) Administration offices
9) Staff conference room
10) Soiled linen room
11) Storage: special equipment
Materials
Other

In teaching units

12) Teaching areas
13) Audio-visual workshop
14) Students' changing
15) Students' viewing and discussing

1.4 General Planning Considerations

1) Ultrasound scanning devices do not utilize X-rays or radionuclides; therefore the facilities require no lead shielding in their construction.

2) Both ultrasound and computerized radiographic tomographs produce cross-section images, but they operate on different principles:

   - In ultrasound, images are the result of measuring echoes between substances.

   - In tomography, images are the result of measuring X-ray absorption.

Due to the "explosion" in the use of ultrasonic equipment in the early 1970's, the planners of ultrasonic facilities should not base their requirements on present needs and present models of equipment, but should bear in mind future rapid changes, more acceptance of the use of new techniques in new specialities in the health field, and new models of equipment of different sizes.

The major advantages of ultrasound over other types of diagnostic procedures are:

- the instantaneous evaluation (5 seconds a sweep),
- the non-invasive technique,
- the patient's comfort (no suspension of respiration or long, fixed position),
- new possibilities for biopsies,
- cost is not very high.

There are benefits in having ultrasound closely related to the X-ray department. The main ones are:

1) For diagnostic purposes: In some instances, ultrasound is used for preliminary studies, the findings of which may be confirmed by radiologic or other studies.

2) For developing purposes: When a film format is used instead of an instant developing film, the processor within the X-ray department can be used for developing ultrasound images.

3) For filing purposes: In some cases ultrasonograms are filed in the patients' X-ray folders.

4) For administration purposes: Secretarial spaces, administration, and other offices could be shared with the X-ray department.

1.5 Circulation

Access. Doors to the examination rooms should be wide enough to admit carts or beds.

Patient's Transfer. When possible, the layout of the room should be such that the patient's transfer to the examination table occurs smoothly. This will require an additional space of approximately 914 x 1828 mm (3ft x 6ft) parallel and immediately adjacent to the bed.

Provision should be made to have a parking space for the stretcher or bed away from the working space; this parking space could be provided inside the room, or outside it in a niche off the corridor circulation.

Additional space for teaching: In teaching units provisions should be made for additional people to stand immediately around the patient's bed.

Special care should be taken when positioning additional monitors on both sides of the examination table to ensure that both the doctor and his students have a direct view of the patient and the monitor.

In teaching units special attention should be given in the layout to the location of high density educational areas (lecture rooms, small amphitheatre, projection room, etc.).

Access to these areas should not interfere with the clinical areas, noise should be controlled, and students' support areas should be clearly defined away from the ones allocated to the main staff.

In all units there is a need for changing rooms and washrooms. In teaching units students should have their own changing rooms, washrooms, and in some instances private or group work areas.

1.6 Privacy

During scanning, the patient should have a sense of security from being seen by persons outside the room other than the staff in charge. The architect should design his layout to give patients the utmost privacy; he should avoid full reliance on curtains or screens, and should position the doors carefully in order to avoid visual access from corridors. One reason for the necessity of visual protection is the frequent use of diagnostic ultrasound for pregnancies.

1.7 Other Space Requirements

When image reading occurs in the examination room in addition to scanning, additional space should be provided for a wall-mounted viewer and adequate standing space for the staff viewing it.

In small non-teaching units, patients' changing could occur in the examination room; in such a case, curtains or screens are provided within the room for the patients' privacy. This alternative is not efficient in units with a high patient load. In such cases it is preferable to have cubicles for outpatients' undressing, the same as in X-ray departments. These cubicles should have direct access to the examination rooms.

Full bladder and pelvis examinations require a bathroom in the vicinity of the ultrasound area as in some cases the patient has to be examined both with a full and an empty bladder. It is desirable to provide at least one examination room with a bathroom.

The variable time required for various types of scans makes it necessary to have the following:

1. Comfortable waiting areas, preferably separate for inpatients and outpatients. The area for inpatients should be large enough for a number of stretchers to be parked; a minimum of one per examination room. These stretchers should be visually protected from the outpatients' waiting area.

2. Appropriate call systems.

3. Adequate signage to the reception desk to ease check out for patients.

4. Washrooms and other supporting services. (Routine obstetrics scans take approximately 15 minutes, including the patient's dressing time, while abdominal examinations can take up to an hour.)

1.8 Equipment

Due to the various categories of diagnostic ultrasound equipment, its variable size, and possible future changes in the considerations governing the choice of such equipment, space allocation should be carefully studied so that different models of equipment of different sizes can be accommodated at different times in the life span of the unit with the minimum number of alterations in its layout.

An example of a sophisticated piece of equipment is one that has been developed for ultrasound and is being tested in some units; its space requirements are totally different from the usual ones in that it uses a water mattress for the patient's comfort, it is computerized, and it has various gadgets for better performance. Therefore, a lot of electronic machinery and mechanical lifts are needed to move the patient on the examination plane of the machine, etc. The space required for accommodating the machines, in addition to a circulation space for maintenance and repair, is approximately 27-28 m^2 (300 sq. ft.) apart from the public circulation space, changing cubicles, etc.

1.9 Storage and Retrieval of the Recorded Image

Three main types of format are generally used in ultrasound:

- polaroid films,
- transparency sheet film,
- hard paper copy prints.

All of these formats adapt to a 8 1/2" x 11" file folder. In that case the system of filing and the volume of filing space should be based on the workload and on the maximum period of retaining the files.

When designing the filing space, the architect should first determine with the users the filing system to be applied. When many departments file the ultrasonogram in the patient's X-ray folder, they usually insist on having duplicates of the patient's reports or summary cards maintained in the department for ready reference.

Polaroid. Images are usually displayed on black and white polaroid films, hence the large consumption of polaroid films in ultrasound (six to ten films for a thorough obstetric examination). This often results in garbage problems which, although considered minor by most planners, result in circulation in work areas being obstructed by large amounts of garbage films.

Transparencies. Images may be recorded on roll films for teaching or record purposes; in that case films can be processed by X-ray film processors, and would require absolute darkness.

1.10 Materials

Linen supplies per examination consist of:

- at least one table cover,
- one patient's cover sheet,
- one large towel.

Patients with fistulas or other drains may require considerably more laundry support.

Depending on the number of patients and the workload in the unit, it is essential to establish with the users a clear policy on the most suitable system for clean linen supply and soiled linen collection (nursever, large basket for soiled linen, shelf in the room for clean linen, etc.), as it will affect the layout and size of the examination rooms.

1.11 Audio-visual Teaching Requirements

In some independent, non-sharing teaching units, there is a need to accommodate a technician in a workshop type of room for editing tapes, preparing programs, recording, mixing, running the films, and storing the videotapes. This applies only when ultrasound is part of a large department. In some cases this function can be shared.

Special storage space should be considered in teaching units for the bulky pieces of audiovisual equipment, i.e., TV apparatus, cameras on wheels, hanging lights, viewers, projection camera, etc.

In the layout of the teaching classroom or conference room special considerations should be given to all the above mentioned equipment.

BIBLIOGRAPHY

Diagnostic Ultrasound

Planning Guide for radiological installations,
Edited by William J. Tuddenham, M.D.,
Prepared under the auspices of the Committee on Department Planning
Commission on radiology equipment and facilities,
American College of Radiology.

VISITS

Thomas Jefferson's Health Center,
Department of Ultrasound,
Philadelphia, U.S.A.

Presbyterian Hospital,
Department of Ultrasound,
New York, U.S.A.

Mount Sinai Hospital,
Department of Ultrasound,
Toronto, Ontario.
Canada.

2. MECHANICAL DESIGN CONSIDERATIONS

2.1 General

The diagnostic ultrasound unit is designed to provide specialized diagnosis with the help of ultrasound equipment.

Since the patient's skin is lubricated for better contact with the ultrasound probe, it is very sensitive to temperature differences, which should be strictly controlled. Therefore, it is most important that the temperature differential between the supply and return air points of the air-conditioning system be kept, where possible, within the minimal range.

2.2 Plumbing

2.2.1 All plumbing systems should be designed and installed according to the National Building Code, Part 7, provincial and local codes, and CSA Standard Z317.1-M1978.

2.2.2 The patient's washroom should have the following fixtures:

- the water closet should be an elongated syphon jet bowl, preferably wall hung, with flush valve located on the side of the toilet, which should have a free back to lean on and an open seat with integral check hinge or seat bumpers. Handbars should be located on both sides of the toilet for left and right handed patients.

- the lavatory should be vitreous china with antisplash rim, soap dishes, overflow and drain without stopper, and integral perforated grid. The water supplies fitting should have 4" wrist control handles and gooseneck spout with aerator. The model of the lavatories and their heights should be selected for wheelchair patients.

2.2.3 The staff's washroom should have the same fixtures as above without handbars at the toilet.

2.2.4 One lavatory with 4" wrist control handles and gooseneck spout with aerator is required in the examination (diagnostic) room.

2.2.5 A stainless steel counter top sink with gooseneck faucet, hot and cold water supplies and 4" wrist control handles, is required in the nurses' station area.

2.3 Fire Protection

2.3.1 The fire protection system of this unit should correspond to all requirements related to fire safety as defined by the National Building Code, Parts 3 and 6, and all other provincial and local fire regulations.

2.4 Medical Gases

2.4.1 The medical gas system should be designed and installed according to the CSA Standard Z305.1-1975 edition, with all the latest revisions.

2.4.2 Each cubicle (diagnostic station) in the treatment room may have one oxygen outlet.

If the piped oxygen is not available, a portable oxygen set should be kept at the nurses' station.

2.5 Environment Control

2.5.1 The environment control should be designed in accordance with the National Building Code, Part 6, CSA Standard 317.2, which is in the preparatory stage, and all other provincial and local codes which apply.

2.5.2 Heating. Induction units and steam should not be used as any part of the direct heating system in this unit.

Each zone (group of rooms), if any, should have temperature control by its own thermostat, and the thermostat should be the enclosed type, key operated without any thermometers.

The winter design temperature range for the diagnostic ultrasound unit should be 20°C to 24°C (68°F to 75°F) with 30% relative humidity.

2.5.3 Ventilation and air-conditioning should be provided with up to four air changes per hour for all rooms except washrooms, where the exhaust should be sized for up to 10 air changes per hour.

The summer design temperature range should be 24°C to 27°C (75°F to 80°F) with 55% relative humidity.

2.5.4 Supply air and exhaust air systems for this unit should be considered with double speed fans and a night setback device in the control system to save energy as the unit may operate only during scheduled hours.

3. ELECTRICAL DESIGN CONSIDERATIONS

3.1 Power Supply Characteristics

The diagnostic ultrasound unit is normally located within the structure of a general hospital. The unit should be supplied with electrical power by a feeder from the power distribution panelboard serving that particular area of the hospital. A panelboard feeding lighting, receptacles, and appliances, etc., should be located within or near the unit's areas, and both feeder and panel should be sized to contain at least 25% spare circuit capacity for future load growth. All panels should contain a typewritten directory, mounted inside the panel door, identifying the load served by each circuit.

The electrical installation should comply with the requirements of the Canadian Standards Association, Canadian Electrical Code, Part I, entitled "Safety Standards for Electrical Installations", as well as applicable local codes. Materials used in the electrical system installation should be of the very best quality to ensure reliability and durability. It is false economy to attempt to reduce construction costs by using inferior grade materials. This procedure often increases maintenance and repair costs and contributes to frequent failures, extended periods of down time and inefficient operation.

3.2 Emergency Lighting

Emergency lighting, independent of the general lighting, may be provided so that illumination will be automatically available in the event of failure of the normal lighting system.

Emergency lighting should consist of individual battery-operated units located in each of the ultrasound examination rooms and in the reception area.

The unit equipment should consist of: (1) a rechargeable battery; (2) a battery charging means; (3) provision of one or more lamps mounted on the equipment; and (4) a relaying device arranged to energize the lamps automatically upon failure of the normal supply to the building or failure of supply circuits within the building.

The unit's equipment for emergency lighting should be certified to CSA Standard C22.2 No. 141, and should be installed in accordance with Section 46 of the Canadian Electrical Code, Part 1.

3.3 Switches and Receptacles

Switches used throughout the diagnostic ultrasound unit should be the silent or quiet type, specification grade, with locater lights.

Receptacles should be specification grade, rated 15 or 20 amperes, 3-wire, "U"-ground, 125-volts. In each ultrasound examination room, at least one 30-ampere, 125-volt receptacle should be provided to accommodate the ultrasound equipment. This outlet should be supplied with a separate circuit from the panelboard supplying electrical power to the area. (Various

manufacturers may have different power supply requirements; therefore, it is suggested that the equipment manufacturer be consulted to establish exact power supply needs). An adequate number of 15 to 20-ampere, 125-volt, duplex receptacles should be installed in each ultrasound examination room and in each room of the diagnostic ultrasound unit to accommodate the requirements for plug-in service for equipment and to comply with the regulations of the Canadian Electrical Code.

3.4 Communication Systems

3.4.1 Voice Paging System. A voice paging or public address system should be provided in the diagnostic ultrasound unit. This system may be part of the hospital's main voice paging system and will provide voice communication between the unit and all other supporting departments in the hospital such as radiology, obstetrics, gynecology, cardiology, surgery, biomedical engineering (if present), etc.

3.4.2 Intercommunication System. A separate two-way communication system within the unit itself is recommended. This system would interconnect all locations inside the unit, i.e., the ultrasound examination rooms, the reception area, the physician's office, the administration area, the staff conference room, teaching areas and audio-visual workshop (if present), the film processing room, the record room, etc. The system would handle internal intercommunication only.

3.4.3 Telephone System. Telephone facilities are required in the doctor's office, reception and records offices, the technicians' offices, and in each of the ultrasound examination rooms. A telephone with a long cord should be available in the examination room so that a sonographer can answer calls if he is in the middle of a procedure. A public coin-operated telephone may be installed in the patients' waiting area if desired.

3.5 Lighting

The lighting system for most of the rooms in the diagnostic ultrasound unit should conform with the lighting design for similar areas in the rest of the hospital, e.g., reception, waiting, changing, bathrooms, administration, doctors' offices, conference rooms, audio-visual rooms, etc. Recommendations for lighting these areas are well documented in the latest edition of the lighting handbook published by the Illumination Engineering Society.

Special care should be taken in the lighting treatment applied to the ultrasound examination rooms. Frequently the patient is in a prone position where, his major field of vision is the ceiling. High brightness ratios and glare sources will cause excessive annoyance and visual discomfort to the patient in this position. It is recommended, therefore, that fluorescent cove type lighting around the perimeter of the room be considered for these rooms. The lighting should be dimmer controlled so that the operator may reduce the lighting level of the room for better viewing of the image on the ultrasound equipment screen. An interference-free type dimmer should be

used. Lighting levels in the examination rooms should be approximately 70 footcandles (75 dekalux)[1] on the task when the room is undimmed.

Viewboxes should be provided for film viewing in the ultrasound examination rooms, the doctor's office and the conference room (if such is provided).

3.6 Closed Circuit Television Systems

If the diagnostic ultrasound unit also contains a teaching component, a closed circuit television system with remote video monitor may be a great asset. With a remote video monitor located in the conference room or teaching area, students are able to follow a technical examination, and pertinent anatomic and diagnostic features may be discussed away from the patient's side.

In addition, if the office of the physician responsible for the ultrasound unit is far removed from the unit's geographic location in the hospital, a remote television monitor in his office would allow the physician constant supervision.

3.7 Fire Alarm System

An electrically-supervised, automatic fire detection and alarm system consisting of manually-operated fire alarm stations, automatic fire detectors, and audible devices should be provided for the diagnostic ultrasound unit. The system should meet the requirements of Section 32, CSA Canadian Electrical Code, Part 1, Standard C22.1-1975.

Manually-operated fire alarm stations should be installed near all exits from the unit, and rate-of-rise automatic fire detectors should be installed in all rooms thoughout the unit.

Audible devices used to sound the alarm in the unit should be chimes and should be of sufficient volume to warn all staff members wherever they may be located in the course of their duties.

Since the diagnostic ultrasound unit is part of the hospital, the fire alarm system for the unit should be integrated with the institution's existing fire detection and alarm system.

3.8 Grounding

The grounding system in the diagnostic ultrasound unit should be installed to comply with the grounding requirements of the Canadian Electrical Code, Part I. The branch-circuit panelboard serving the unit should have an equipment grounding bus. The branch-circuit supplying receptacles in the unit should have a separate equipment grounding conductor run in the same enclosure as the circuit conductors. The equipment grounding conductor

---

[1] A dekalux is a metric unit equal to 0.93 footcandles.
1 dekalux equals 10 lux.

should be insulated copper conductor and of the same size as the circuit conductors. It should be connected to the enclosure in which the receptacles are installed and should terminate on the equipment grounding bus of the panelboard supplying the branch-circuit.

3.9 Equipment Maintenance

A planned preventative maintenance program should be instituted to ensure that all critical parameters of the ultrasound equipment are regularly verified as to accuracy, safety and effectiveness. The maintenance program should also include regular inspections and testing of the electrical distribution system to and in the unit, including the safety of the wiring system and the adequacy of the grounding system.

A systematic formalized maintenance program will not only ensure the safe and effective operation of all equipment in the diagnostic ultrasound unit, but will also extend equipment life, reduce costly failures, and promote more efficient utilization. Maintenance schedules, frequency of testing, and the number of personnel assigned to the work will depend largely on the needs and activities carried out in each unit.